REMARKS

Claims 1-25 are pending in this application. Claims 26-76 have been cancelled due to the election requirement of the previous Office action. Claim 77 is new and is supported in the specification at least in paragraph [0029]. Claim 78 is new and is supported in the specification at least in paragraph [0184]. No new matter has been added.

Rejections Under 35 U.S.C. § 103(a)

The Examiner asserted that claims 1-13, 18, and 20-22 are unpatentable over Gill (U.S. 6,456,469 B1) in view of Lee et al. (hereinafter Lee) (U.S. 5,731,936) under 35 U.S.C. §103(a). Applicants respectfully disagree.

To establish a *prima facie* case of obviousness, there must be some suggestion or motivation to combine reference teachings. Such motivation or suggestion is absent from the cited references. The present claims recite an exchange coupled device with a seed layer having a Cr content of 35 to 60 atomic percent and a thickness of 10 to 200 Å. The claimed structure solves the problem that at high Cr concentrations, which are preferable to improve wettability, the body-centered cubic (BCC) phase structure begins to appear in the seed layer, which is undesirable. One of ordinary skill in the art would be inclined to consult a phase diagram in order to control the phase structure present in the seed layer. Phase diagrams show the dependence of phase structure on the chemical composition of a given material system, as shown for example in the ternary phase diagram presented in FIG. 9 of the present application. It is known in the art that changing the composition of a material system can alter the phase structure. Thickness, however, is not a parameter represented on a phase diagram. Indeed, the dimensions of a given material (e.g., the thickness) are not generally known in the art to influence the phase structure of a material system. One of ordinary skill in the art would not be inclined, therefore, to modify the thickness of a seed layer in order to alter its phase structure. Neither reference cited by the Examiner teaches or suggests this idea. Indeed, neither reference shows any recognition that if <u>both</u> the composition and the

thickness of the seed layer are provided within the ranges specified in the present claims, the appearance of the BCC phase structure in the seed layer can be avoided and the wettability of the seed layer can be improved.

Furthermore, neither reference shows or suggests that the claimed seed layer structure improves the (111) crystal orientations of the layers deposited onto the seed layer and the performance of the exchange-coupled device. Without recognition of the combined effect of composition <u>and</u> thickness in controlling the structure and properties of the seed layer, one of ordinary skill in the art would not be motivated to combine a seed layer of the thickness specified by Gill with a seed layer of the composition specified by Lee.

Applicants respectfully disagree with the assertion of the Examiner that one of ordinary skill in the art would have been motivated to combine the spin valve device of Gill with seed layer of Lee "so that the sense current can be increased," thereby arriving at present claims 1-5.

The seed layer of Lee is part of a magnetoresistive (MR) sensor that is different in terms of both layer structure and operational principles from the spin valve device of Gill. MR sensors operate at higher levels of sense current than do spin valve devices. A higher sense current gives rise to a larger output signal. However, it also raises the current density (i.e., sense current per unit area). If the current density reaches an excessive level, device performance will be degraded and ultimately the device may break down. It is well known that spin valve devices are much smaller in size than MR sensors. As a result, for a given sense current, a spin valve device would be exposed to a significantly higher current density than would an MR sensor. For this reason, spin valve devices are more sensitive to increases in sense current than are MR sensors. In fact, spin valve devices are limited by current density considerations to <u>lower</u> levels of sense current than are MR devices.

Knowing that an excessive current density is detrimental to device performance, one of ordinary skill in the art would not be inclined to look at MR sensor technology, which operates at a higher sense current than spin valve technology, to arbitrarily increase the sense current in a spin valve device. Therefore, the Examiner has not provided a motivation for why one of ordinary skill in the art of spin valve or exchange

coupled devices would combine the teachings of Lee with Gill to arrive at the present invention.

Furthermore, as noted above, the seed layer of Lee is part of an MR sensor that is different in terms of both layer structure and operational principles from the spin valve device of Gill. The MR sensor of Lee does not operate on the basis of exchange coupling, as does the spin valve device of Gill and the present invention. Because of the different operational principles of a spin valve device as compared to an MR sensor, the layer structures of the two devices are different. The Examiner has provided no motivation for why one of ordinary skill in the art of exchange coupled devices would look to devices that have different layer structures and different operational principles for a seed layer. Applicants point out that, in the spin valve device of Gill, the seed layer lies below an antiferromagnetic layer. In Lee, the seed layer lies below a ferromagnetic layer. (The MR sensor of Lee does not even contain an antiferromagnetic layer.) As Gill states in col. 3, lines 43-45: "The crystalline structure and orientation of the seed layer determine the configuration of the remaining layers." Because a particular seed layer is selected depending on the layers deposited above it, it would not be obvious to use a seed layer selected to lie below a ferromagnetic layer in an MR device as a seed layer for an antiferromagnetic layer in an exchange coupled device, which has an entirely different arrangement of layers.

Absent a suggestion or motivation to combine reference teachings, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, a *prima facie* case of obviousness has not been established. Applicants therefore respectfully request that the Examiner withdraw the rejection against claims 1-5 in light of the preceding arguments.

In regard to claims 6-7, Applicants believe that they are patentable based on the preceding arguments. Applicants therefore respectfully request that the Examiner withdraw the rejection of these claims in light of these arguments.

In regard to claims 8-11, the Examiner asserted that one of ordinary skill in the art would have been motivated to provide the spin valve sensor of Gill with the seed

layer as taught by Lee "so that the sense current can be increased" and "to increas[e] the MR coefficient of the MR stripe." In the prior section, Applicants explained that one of ordinary skill in the art would not be inclined to look to MR sensor technology, which operates at a higher sense current than spin valve technology, to arbitrarily increase the sense current of a spin valve device. Furthermore, applicants point out once again that the seed layer of Lee is part of an MR sensor that is different in terms of both structure and operational principles from the spin valve device of Gill. The MR stripe present in the device of Lee is <u>not present</u> in an exchange coupled device, including that taught by Gill and the present invention. Clearly then, in arriving at the present invention, there could not have been a motivation to increase the MR coefficient of an MR stripe <u>that does not exist</u>.

Absent a suggestion or motivation to combine reference teachings, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, a *prima facie* case of obviousness has not been established. Applicants therefore respectfully request that the Examiner withdraw the rejection against claims 8-11.

Regarding claims 12-13, the Examiner asserted that one of ordinary skill in the art would have been motivated to provide the spin valve sensor of Gill with the seed layer as taught by Lee "to increas[e] the MR coefficient of the MR stripe." In the prior section, Applicants have explained that the MR stripe of Lee is <u>not present</u> in an exchange coupled device, including that taught by Gill and the present invention. As a result, in arriving at the present invention, there could not have been a motivation to increase the MR coefficient of an MR stripe <u>that does not exist</u>.

Absent a suggestion or motivation to combine reference teachings, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, a *prima facie* case of obviousness has not been established. Applicants therefore respectfully request that the Examiner withdraw the rejection against claims 12-13.

The Examiner alleged that Gill discloses the limitations of claim 18 in col. 6, lines 25-32. Applicants respectfully disagree. Claim 18 recites grain boundaries that are at least partially discontinuous at an interface between the antiferromagnetic layer and the seed layer. Gill does not disclose such an arrangement in the section cited by the Examiner or anywhere else in the reference. In fact, Gill makes no mention whatsoever of grain boundaries, let alone grain boundaries that are at least partially discontinuous at the interface between the antiferromagnetic layer and seed layer.

Because the references, alone or in combination, do not recite each and every element of claim 18, a *prima facie* case of obviousness has not been established. Applicants respectfully request that the Examiner withdraw the rejection of claim 18.

The Examiner asserted that Gill discloses the limitations of claim 20 at col. 6, lines 25-32. Applicants respectfully disagree. Claim 20 requires that "at least some of the equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the seed layer." Gill does not recite, either in the section cited by the Examiner or elsewhere in the reference, <u>crystal axes</u> of equivalent crystal planes <u>directed in different directions</u>. Furthermore, on page 8 of the Office action in a rejection directed to claim 19, the Examiner himself acknowledged that "Gill and Lee disclose all the features, *supra*, but do not disclose...at least some of the equivalent crystal axes in the crystal planes are directed in different directions between the antiferromagnetic layer and the ferromagnetic layer."

Because the references, alone or in combination, do not recite each and every element of claim 20, as acknowledged by the Examiner, a *prima facie* case of obviousness has not been established. Applicants respectfully request that the Examiner withdraw the rejection of claim 20.

In regard to claims 21 and 22, Applicants believe they are patentable, based on the preceding arguments. Applicants therefore respectfully request that the Examiner withdraw the rejection of these claims in light of these arguments.

The Examiner asserted that claims 14-16 are unpatentable over Gill (U.S. 6,456,469 B1) and Lee et al. (hereinafter Lee) (U.S. 5,731,936) as applied to claim 1 above and further in view of Ohta et al. (U.S. 5,958, 611) under 35 U.S.C. §103(a). Applicants respectfully disagree. Claims 14-16 require that an average crystal grain size in a direction parallel to a layer surface in each layer formed on the seed layer is at least 100 Å. Ohta does not disclose this limitation. He discloses only a crystal grain size for an antiferromagnetic layer. Furthermore, he does not specify a crystal grain size in a direction parallel to a layer surface.

Because the references, alone or in combination, do not recite each and every element of claims 14-16, a *prima facie* case of obviousness has not been established. Applicants respectfully request that the Examiner withdraw this rejection.

The Examiner asserted that claims 17, 19, and 23-25 are unpatentable over Gill (U.S. 6,456,469 B1) and Lee et al. (hereinafter Lee) (U.S. 5,731,936) as applied to claim 1 above and further in view of Hasegawa et al. (hereinafter Hasegawa '647) (English translation of JP 11-191647, publication date 7/13/99) under 35 U.S.C. §103(a). Applicants respectfully disagree.

Applicants include herewith as Appendix A an English translation of paragraphs [0017] and [0019] - [0021] of Hasegawa '647. It is clear from the translation of paragraph [0017] that Hasegawa does not disclose the limitations of claim 17. In particular, claim 17 recites "grain boundaries formed in the antiferromagnetic layer and grain boundaries formed in the ferromagnetic layer...are at least partially discontinuous at the interface between the antiferromagnetic layer and the ferromagnetic layer." Hasegawa does not disclose such an arrangement. Specifically, Hasegawa '647 makes no reference to grain boundaries in the exchange coupling film nor to any discontinuity between them. Applicants also point out that the machine translation cited by the Examiner makes no reference to grain boundaries.

Because the references, either alone or in combination, do not recite each and every element of claim 17, a *prima facie* case of obviousness has not been established. Applicants respectfully request that the Examiner withdraw the rejection of claim 17.

The Examiner also alleged that paragraph [0021] of Hasegawa '647 teaches the limitations of claim 19. Applicants respectfully disagree. Claim 19 recites that "equivalent crystal planes represented as {111} planes in the antiferromagnetic layer <u>and</u> the ferromagnetic layer are preferentially oriented as crystal planes parallel to the interface..." (Emphasis added.) Referring to the English translation of paragraphs [0019]-[0021] provided in Appendix A, it is clear that Hasegawa '647 does not disclose such an arrangement. To the contrary, Hasegawa '647 recites that {111} crystal planes in the ferromagnetic layer are oriented in parallel with the interface and that {111} crystal planes in the antiferromagnetic layer are <u>non-oriented</u>. Specifically, in paragraph [0019], Hasegawa '647 discloses that "while the {111} plane of the ferromagnetic layer is disposed preferentially in a direction parallel to the interface with the antiferromagnetic layer, the degree of orientation of the {111} plane of the antiferromagnetic layer <u>is less than the degree of orientation</u> of the ferromagnetic layer or is <u>non-oriented</u>." (Emphasis added.) Hasegawa '647 clearly does not disclose the limitations of claim 19, which requires that equivalent crystal planes in <u>both</u> the antiferromagnetic and ferromagnetic layer are oriented in parallel with the interface.

Because the references, either alone or in combination, do not recite each and every element of claim 19, a *prima facie* case of obviousness has not been established. Applicants respectfully request that the Examiner withdraw the rejection of claim 19.

In regard to claim 23, the Examiner asserted that it would have been obvious to one of ordinary skill in the art to form the X-Mn-X' alloy of Gill and Lee as an interstitial solid solution as taught by Hasegawa '647 in order to increase the lattice constant of the antiferromagnetic layer so that the interface structure between the antiferromagnetic layer and the ferromagnetic layer can be incoherent. Applicants respectfully disagree.

The motivation proposed by the Examiner to combine the teachings of Hasegawa '647 with those of Gill and Lee is <u>in complete opposition to</u> the teachings of Gill. In col. 6, lines 33-37, Gill states: "Furthermore, layer textures are improved when the lattice constants of adjacent layers are similar...Similar lattice constants permit the crystals of adjacent layers to align with each other..." Clearly, Gill teaches that <u>similar</u> lattice constants for adjacent layers are desirable. In contrast, Hasegawa '647 teaches

that lattice constants for adjacent layers are preferably different. Specifically, in paragraph [0043] cited by the Examiner, Hasegawa '647 recites that the lattice constant of the antiferromagnetic layer should be larger than that of the ferromagnetic layer so that the interface between the two layers is incoherent (discontinuous).

Furthermore, Gill recites that the interface between layers is not incoherent, in contradiction to the teaching of Hasegawa '647 (paragraph [0043]) that the interface between the antiferromagnetic and ferromagnetic layers is incoherent. Specifically, at col. 6, lines 28-30, Gill states: "Interfaces between layers have few discontinuities (misaligned sets of atoms) or interstices (open spaces where atoms should be). Because Gill clearly teaches away from the disclosure of Hasegawa '647, there can be no motivation to combine Gill with Hasegawa '647 in order to arrive at the present claim.

Absent a suggestion or motivation to combine reference teachings, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, a *prima facie* case of obviousness has not been established. Applicants therefore respectfully request that the Examiner withdraw the rejection against claim 23.

In regard to claims 24 and 25, the Examiner asserted that it would have been obvious to one of ordinary skill in the art to form the X-Mn-X' alloy of Gill and Lee with the X content and the X+X' content as taught by Hasegawa '647 in order to control the composition ratio of element X of the X-Mn alloy so that the difference between the lattice constants of the X-Mn alloy (antiferromagnetic layer) and the ferromagnetic layer is large before heat treatment, and the interface structure may be put into an incoherent state. Applicants respectfully disagree.

As in the rejection to claim 23, the motivation proposed by the Examiner to combine the teachings of Hasegawa '647 with those of Gill and Lee is in complete opposition to the teachings of Gill. In col. 6, lines 33-37, Gill states: "Furthermore, layer textures are improved when the lattice constants of adjacent layers are similar...Similar lattice constants permit the crystals of adjacent layers to align with each other..." Clearly, Gill teaches that similar lattice constants for adjacent layers are desirable. In contrast, Hasegawa '647 teaches that lattice constants for adjacent layers are preferably different. Specifically, in paragraph [0043] cited by the Examiner, Hasegawa

'647 recites that the lattice constant of the antiferromagnetic layer should be larger than that of the ferromagnetic layer so that the interface between the two layers is incoherent (discontinuous).

Furthermore, Gill recites that the interface between layers is not incoherent, in contradiction to the teaching of Hasegawa '647 (paragraph [0043]) that the interface between the antiferromagnetic and ferromagnetic layers is incoherent. Specifically, at col. 6, lines 28-30, Gill states: "Interfaces between layers have few discontinuities (misaligned sets of atoms) or interstices (open spaces where atoms should be). Because Gill clearly teaches away from the disclosure of Hasegawa '647, there can be no motivation to combine Gill with Hasegawa '647 in order to arrive at the present claims.

Absent a suggestion or motivation to combine reference teachings, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, a *prima facie* case of obviousness has not been established. Applicants therefore respectfully request that the Examiner withdraw the rejection against claims 24-25.

New claim 77 recites an exchange coupled film according to claim 1, wherein the crystal structure of the seed layer is substantially a single phase, and wherein a body-centered cubic structure is substantially not present. The prior art references do not disclose or suggest a seed layer with these limitations. Applicants submit, therefore, that claim 77 is patentable, and respectfully request that the Examiner allow this claim.

New claim 78 recites an exchange coupled film according to Claim 1, wherein the antiferromagnetic layer comprises an X-Mn-X' alloy, wherein X is at least one element selected from the group consisting of Pt, Pd, Ir, Rh, Ru, and Os and X' is at least one element selected from the group consisting of Ne, Ar, Kr, and Xe. The prior art references do not disclose or suggest the combination of elements of claim 78. Applicants submit, therefore, that claim 78 is patentable, and respectfully request that the Examiner allow this claim.

SUMMARY

Applicants believe that the currently pending claims are in condition for allowance. The Examiner is invited to contact the undersigned agent for the Applicants via telephone if such communication would expedite allowance of this application.

Respectfully submitted,

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APPENDIX A

English Translation of Sections [0017], [0019], [0020] and [0021] of Hasegawa '647 Provided by Mr. Alan Siegrist of Siegrist Translations in Orinda, CA

[0017]
[Means of Solving the Problem]
The present invention is an exchange-coupled film formed by placing an antiferromagnetic layer and a ferromagnetic layer in contact and performing heat treatment to give rise to an exchange anisotropic magnetic field at the interface between the antiferromagnetic layer and ferromagnetic layer, and the direction of magnetization of the ferromagnetic layer is fixed in a certain direction, wherein: the antiferromagnetic layer is formed from antiferromagnetic material containing at least Mn and the elements *X* (where *X* is one or two or more elements selected from a group consisting of Pt, Pd, Ir, Rh, Ru and Os), and the structure of the interface between the antiferromagnetic layer and ferromagnetic layer is a disordered state.
...
[0019] In the present invention, while the {111} plane of the ferromagnetic layer is disposed preferentially in a direction parallel to the interface with the antiferromagnetic layer, the degree of orientation of the {111} plane of the antiferromagnetic layer is less than the degree of orientation of the ferromagnetic layer or is non-oriented.

[0020] Alternately, while the {111} plane of the antiferromagnetic layer is disposed preferentially in a direction parallel to the interface with the ferromagnetic layer, the degree of orientation of the {111} plane of the ferromagnetic layer is less than the degree of orientation of the antiferromagnetic layer or is non-oriented.

[0021] Alternately, both the degree of orientation of the {111} plane of the antiferromagnetic layer and the degree of orientation of the {111} plane of the ferromagnetic layer with respect to a direction parallel to the interface between the antiferromagnetic layer and ferromagnetic layer are small or non-oriented, a crystal plane other than the {111} plane is preferentially oriented in a direction parallel to the interface, and the antiferromagnetic layer and ferromagnetic layer have different crystal orientations.